Science & Technical Support Section's
SciFYI
King County
Department of Natural Resources and Parks
Water and Land Resources Division
A science section digest of current environmental issues in King County
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Cooling down streams: addressing warm summer water temperatures in Green River Tributaries

By Andrew Miller and Chris Knutson

There are many ecological benefits to planting trees in riparian areas adjacent to streams and rivers. One of the most important is lowering summer water temperatures which are too high for many aquatic animals. Cool water temperatures are critical for development of salmon and trout, and high temperatures can result in stress and even death. Healthy streamside vegetation provides shade to the channel, blocking solar radiation and reducing the heat reaching the stream.

In spite of this obvious benefit, all streamside planting projects face the question: how much will the trees planted actually affect stream water temperatures? Trying to answer that question is complicated. Vegetation planted adjacent to streams can take decades to fully mature, so direct measurement of its effect on stream temperatures is not practical. However, water quality models can estimate the impact of new vegetation once it reaches maturity. After a series of riparian plantings were completed on Newaukum Creek (**Figure 1**), King County scientists applied water quality models to calculate the increase in effective shade and the associated decreases in solar heat loads and maximum water temperature during critical summer conditions.

Model results showed how vegetation increases effective shade and reduces solar heat loads and maximum temperatures (**Figure 2**). Modeled effective shade increased by as much as 58 percent in Newaukum Creek, while the

FIGURE 1.
Aerial photo showing Newaukum Creek flowing through the Enumclaw Plateau, which lies in the middle section of the Newaukum Creek watershed. While Newaukum Creek supports deciduous vegetation in riparian areas in some portions of the watershed, the Enumclaw Plateau is dominated by agricultural land use leaving the stream banks of Newaukum Creek lacking trees and shrubs. In order to reduce temperatures, King County planted areas along Newaukum Creek in 2012 (shown in green on the map).

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solar heat loads were reduced in planted areas by as much as 61 percent. Modeled water temperature was reduced by as much as 0.9 °C with an average reduction of 0.3 °C in the reach that was planted.

While such temperature reductions may appear modest, this is likely due to the small area planted; only 1.1 percent of the riparian areas of the modeled reach in Newaukum Creek were planted with trees in 2012. It's also important to consider that many riparian areas of Newaukum Creek are largely devoid of trees in the predominantly agricultural Enumclaw plateau (**Figure 1**). Therefore, much of the benefit from adding trees could be lost downstream as water flows through terrain with that receives full sun.

To demonstrate the additional benefit from continued tree planting, a planting scenario was modeled where all riparian areas with little to no vegetation were replaced with mature trees similar to what was planted in 2012 (infill planting scenario in **Figure 2**). This action resulted in an average temperature reduction of 2.5 °C in the reach affected by planting, and an additional 6.0 km of Newaukum Creek was estimated to meet the Washington State summer temperature standard of 16.0 °C. While other factors also affect temperature, such as stream flow discharge, climate, and groundwater influence, the critical importance of shade in controlling temperature in small streams lends credence to this model's utility as a tool for quantifying the thermal benefits of riparian planting.

In addition to the shade modeling effort described above, King County took hemispherical photographs (a digital photograph through a wide angle lens that allows the sky in all directions to be simultaneously visible) of trees overhanging Newaukum Creek along the replanted reaches when trees were planted in 2012 (see **Figure 3**). This process was repeated in 2014 to measure the increase in effective shade from the growth of the newly planted vegetation.

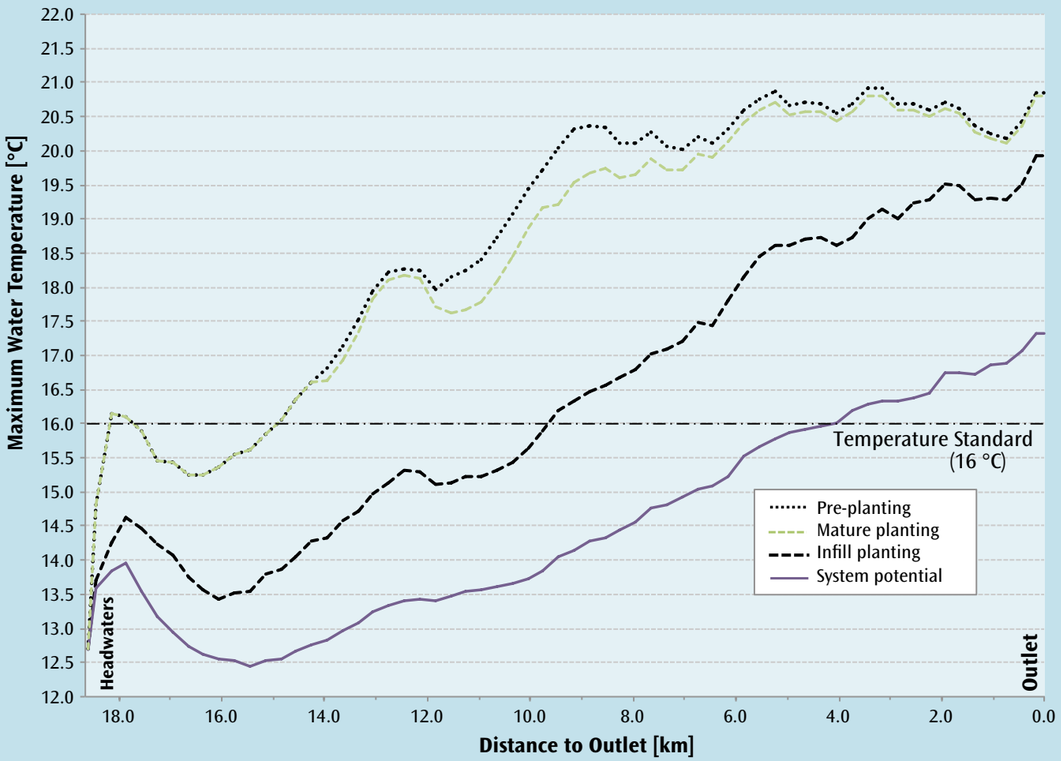

FIGURE 2.
Plot of estimated temperatures along the modeled reach of Newaukum Creek. Each line represents a different planting scenario: the black dotted line (pre-planting) represents conditions prior to the planting on Newaukum Creek in 2012; the green dashed line (mature planting) represents vegetation planted in 2012 reaching maturity; the black dashed line (infill planting) represents a scenario where all unvegetated areas adjacent to Newaukum are planted with small trees that reach maturity; and the solid purple line (system potential) represents a scenario where all areas adjacent to Newaukum Creek being covered in mature coniferous trees.

Most of the data showed moderate increases in effective shade and canopy coverage (5-15%) at the photo locations. These results indicate that even in a short time frame (2 years), as the vegetation matures, it provides a significant shade benefit to the stream.

It is clear that trees provide benefits to adjacent streams. King County will continue to track the growth of planted vegetation through time by repeating the hemispherical photography at regular intervals. It is our goal to create a series of images of the selected reaches that can be used to assess the most effective plant species, planting methods, and plant densities for temperature benefits. The information gathered can also be used to continue the modeling work described above. This is likely to be increasingly important in the future as King County works to adapt to the projected impacts of land-use and climate change.

For the full report, go to http://your.kingcounty.gov/dnrp/library/2015/kcr2677.pdf

FIGURE 3.
Example of a hemispherical photograph taken from the middle of the stream channel in Newaukum Creek in 2012 and 2014. A computer program is used to calculate the amount of solar radiation reaching the stream through the vegetation overhead.

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